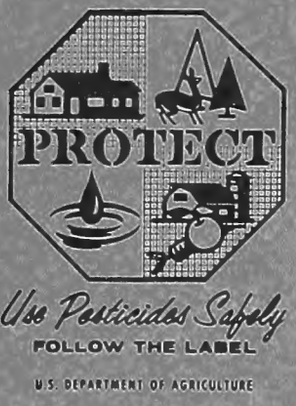
1970
USDA FOREST SERVICE RESEARCH PAPER PNW-95

Storing Endrin-Coated and Endrin-Impregnated Douglas-fir Seed



M.A. Radwan and
H.W. Anderson

CIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION PORTLAND, OREGON
REST SERVICE
U.S. DEPARTMENT OF AGRICULTURE

M. A. RADWAN is Principal Plant Physiologist, Forestry Sciences Laboratory, Pacific Northwest Forest and Range Experiment Station, Olympia, Washington.

H. W. ANDERSON is Forest Scientist, Forest Land Management Center, Washington State Department of Natural Resources, Olympia, Washington.

INTRODUCTION

In direct seeding, bad weather and other unfavorable conditions often necessitate storage of endrin-treated seed for periods of time ranging from a few days to several weeks. During this time, seed viability may be affected, and the effect will probably vary with the method of seed treatment and length and conditions of storage. To determine how to safely store endrin-treated seed, it is necessary to study effects of storage on the seed and establish the best possible storage conditions. Although the results of storing endrin-treated seed have been reported for the southern pine species (Jones 1963, McLemore and Barnett 1966),[1/] no information is available for any of the other important conifers, particularly Douglas-fir *(Pseudotsuga menziesii* (Mirb.) Franco).

Since 1956, the U.S. Bureau of Sport Fisheries and Wildlife has recommended protection of Douglas-fir and other coniferous seed with a coating of 0.5 percent endrin (Anonymous 1956). Recently, we compared endrin content and performance of endrin-coated and endrin-impregnated Douglas-fir seed and discussed the potential usefulness of impregnation (Radwan et al. 1970). In the present study, we have evaluated germination of coated and impregnated seed and performance of resulting seedlings after storage of treated seed at three different temperatures for periods ranging from 1 to 4 months.

MATERIALS AND METHODS

Two lots of Douglas-fir seed from Pierce County, Wash., were tested. The seed was collected in 1964 and 1965 and stored at -4° C. During the winter of 1968, samples were drawn from each lot and divided into four parts. One part of each sample was used as a control, and the other three parts were treated with endrin--one coating and two impregnations. Endrin 50-WP (50-percent wettable powder) from Stauffer Chemical Company[2/] was used for all endrin treatments.

One-half-pound batches of seed were coated with endrin. Concentration of the active ingredient was 0.5 percent by weight. The seed was wetted with a slurry of endrin in the adhesive Dow Latex 512-R, covered with aluminum powder, spread in a thin layer, and allowed to dry overnight under a hood.

[1/] Names and dates in parentheses refer to Literature Cited, p. 6.

[2/] Mention of chemical companies and their products does not represent endorsement by the Forest Service or by the Department of Agriculture.

Impregnation solutions containing 2 percent active endrin were prepared by dissolving endrin 50-WP in each of the two endrin solvents, 1, 2-dichloroethane (D) and trichloroethylene (T), and filtering out the inactive, insoluble ingredients of the powder. Seed was dried in a forced-air oven at 40° C. for 48 hours, enclosed in cheesecloth, dipped in the endrin solutions for 1 hour, and dried in a forced-air oven at 40° C. for 24 hours. This impregnation technique successfully introduced endrin inside seed (Radwan et al. 1970).

Each of the resulting eight treated and control seed samples (three treatments and one control per lot) was divided into 10 parts. Germination and production of seedlings were then determined immediately (no storage) and after storage in polyethylene bags at 20°, 4°, and -4° C. for 1, 2, and 4 months.

Four 100-seed replicates were germinated on perlite at 24°±1° C. after stratification for 21 days at 3° to 5° C., as prescribed in the standard test (Association of Official Seed Analysts 1965). Germinants were counted weekly, and tests were run for 28 days.

Production and growth of seedlings were studied concurrent with perlite germination tests. Two 100-seed replicates of stratified seed were planted in 4- by 4-inch pots about one-eighth inch deep in a mixture of equal parts soil, vermiculite, and peat moss. For germination and initial growth, pots were placed in a plant-growth chamber and watered daily. The chamber was set at 27° C. and 800 foot-candles (ft.-c.) of light for 20 hours per day and at 21° C. for 4 hours of darkness; relative humidity was about 70 percent. At the end of 28 days, the pots were transferred to another chamber and watered every 2 days. Temperatures were maintained at 27° C. during the day and 17° C. at night. Other growth conditions were 60- to 80-percent relative humidity and 1,200 ft.-c. of fluorescent-incandescent light on a 14-hour photoperiod. Seedlings were harvested and counted 50 days after planting. Roots and tops of seedlings were examined and ovendry weights of 10 randomly selected seedling tops from each pot were determined.

RESULTS

Before storage, germination and seedling production of untreated seed were higher for lot 1 than for lot 2 (table 1), indicating a better germination potential of this seed. Treatment with endrin by coating (0.5 EC) or by impregnation from the (D) solvent (EDI) did not affect germination of either lot on perlite or in soil. Impregnation with endrin dissolved in the (T) solvent (ETI), however, reduced germination on perlite but not in soil. Gross comparisons of dry weights and appearance of seedlings indicated no difference between the untreated lots. In addition, seedling growth from either lot of seed was not affected by any of the endrin treatments.

After storage, performance of all endrin-treated seed was almost equal to that of the untreated controls in soil. In addition, as with unstored seed, germination on perlite generally compared well with that in soil except with the

Table 1.--*Effect of storage on germination of endrin-treated and untreated Douglas-fir seed on perlite and in soil and ovendry weight of seedling tops produced in soil*

Seed treatment[1]	Seed lot 1			Seed treatment[1]	Seed lot 2		
	Perlite	Soil	Dry weight[2]		Perlite	Soil	Dry weight[2]
	Percent[3]		*mg.*		*Percent*[3]		*mg.*
NO STORAGE							
Control	88	79	29	0.5 EC	82	74	26
0.5 EC	86	83	32	Control	78	76	25
EDI	83	84	29	EDI	72	74	33
ETI	76	84	30	ETI	65	74	26
1-MONTH STORAGE							
Control (20° C.)	88	90	35	Control (-4° C.)	84	75	28
Control (4° C.)	87	83	27	Control (20° C.)	82	78	30
0.5 EC (4° C.)	86	86	26	0.5 EC (-4° C.)	81	72	29
EDI (4° C.)	86	83	26	Control (4° C.)	81	79	28
0.5 EC (-4° C.)	86	88	25	0.5 EC (4° C.)	76	73	31
Control (-4° C.)	85	85	26	EDI (20° C.)	76	74	32
0.5 EC (20° C.)	84	88	26	0.5 EC (20° C.)	74	68	32
EDI (20° C.)	83	86	27	EDI (-4° C.)	70	78	32
EDI (-4° C.)	82	87	28	ETI (-4° C.)	69	70	27
ETI (20° C.)	80	84	25	EDI (4° C.)	69	73	31
ETI (4° C.)	77	85	29	ETI (20° C.)	62	74	27
ETI (-4° C.)	77	83	26	ETI (4° C.)	62	69	30
2-MONTH STORAGE							
Control (-4° C.)	89	87	22	Control (-4° C.)	83	75	29
Control (4° C.)	88	83	28	Control (4° C.)	82	75	21
Control (20° C.)	88	86	25	0.5 EC (4° C.)	82	79	27
0.5 EC (20° C.)	88	85	22	0.5 EC (-4° C.)	81	77	26
0.5 EC (4° C.)	86	88	23	0.5 EC (20° C.)	80	73	21
0.5 EC (-4° C.)	85	86	26	Control (20° C.)	78	78	23
EDI (20° C.)	83	89	24	EDI (-4° C.)	74	73	27
EDI (-4° C.)	79	88	31	EDI (20° C.)	72	76	26
EDI (4° C.)	78	92	29	EDI (4° C.)	72	82	26
ETI (20° C.)	78	83	29	ETI (20° C.)	66	72	24
ETI (-4° C.)	77	86	25	ETI (-4° C.)	64	73	26
ETI (4° C.)	73	86	26	ETI (4° C.)	64	77	23
4-MONTH STORAGE							
Control (-4° C.)	90	82	28	Control (20° C.)	83	75	23
Control (20° C.)	89	89	24	Control (-4° C.)	80	78	28
Control (4° C.)	88	78	25	0.5 EC (4° C.)	80	75	26
0.5 EC (4° C.)	87	84	24	0.5 EC (-4° C.)	79	79	26
0.5 EC (-4° C.)	84	88	22	Control (4° C.)	78	73	26
EDI (-4° C.)	83	86	24	EDI (4° C.)	77	77	25
0.5 EC (20° C.)	80	82	25	0.5 EC (20° C.)	75	69	24
EDI (20° C.)	80	88	26	EDI (20° C.)	72	76	30
EDI (4° C.)	80	86	24	ETI (4° C.)	69	75	24
ETI (4° C.)	77	85	24	EDI (-4° C.)	68	78	23
ETI (-4° C.)	76	85	26	ETI (20° C.)	68	69	24
ETI (20° C.)	74	83	27	ETI (-4° C.)	65	77	23

[1] Control = untreated, 0.5 EC = endrin-coated at 0.5 percent, EDI = endrin-dichloroethane-impregnated, ETI = endrin-trichloroethylene-impregnated. Storage temperatures are shown in parentheses.

[2] Ovendry weights of tops per seedling are averages of 20 seedlings, 10 tops from each of two pots.

[3] Germination percents are averages of four and two replications each for perlite and soil tests, respectively. Means in the perlite column enclosed by the same line(s) do not differ significantly at the 5-percent level, with a modification of Tukey's test (Snedecor 1961).

ETI seed where results of the perlite tests were significantly lower.

Regardless of storage temperature, germination and seedling growth of endrin-coated and endrin-impregnated seed from both lots averaged nearly the same as those of unstored seed. This was evident at 1 month of storage and continued essentially unchanged throughout the entire 4-month storage period. However, with the endrin-coated seed of both lots, germination in most perlite and soil tests, when seed was stored at 20° C. was slightly lower than that of seed stored at the colder temperatures, indicating that cold storage might be more suitable for such seed.

Untreated and treated seed germinated rapidly both on perlite and in soil. Seedlings began to emerge from the soil by the end of the first week after seeding, and rate of emergence within each storage period was about the same regardless of lot, treatment, or storage temperature. Similarly, based on the proportion of total germination occurring on perlite within the first 2 weeks of each test, germination rate of the individual treatments did not vary with storage or temperature throughout the 4-month storage period. However, the treatments consistently showed different trends and were somewhat slower in germination than the controls. Thus, over all the temperatures and storage periods and based on the 2 weeks' germination of the controls, average rates for the 0.5 EC, EDI, and ETI treatments, respectively, were 97, 82, and 85 percent for lot 1, and 98, 78, and 76 percent for lot 2.

DISCUSSION

During many years of coating Douglas-fir seed with endrin, many forest managers in the Pacific Northwest have assumed that (1) endrin reduces germination to some extent, but reductions are tolerable in view of anticipated protection, and (2) the safest way to store treated seed is to place it under the same subzero temperatures recommended for untreated seed. Results of this investigation do not substantiate these assumptions. Using two seed lots, we found that coating with endrin at the recommended 0.5-percent level did not inhibit seed germination on perlite or in soil. Likewise, endrin-coated seed (0.5 EC) withstood storing satisfactorily for 4 months whether it was left at room temperature, refrigerated at 4° C., or placed at subzero, although seed stored at the colder temperatures showed better total germination in most tests. Obviously, it is impossible to identify conclusively the factor(s) responsible for these results. However, we suggest that drying the seed thoroughly after treatment and storing treated seed in moisture-proof containers were major contributing factors. The adverse effect of high moisture on storing coniferous seed is well known (Barton 1954). In addition, our unpublished data[3/] show that germination of undried seed was reduced by 15 to 30 percent during 2 months of storage at 4° C.

3/ Data on file at the Forestry Sciences Laboratory, Olympia, Wash.

In the evaluation of results for coated seed, it should be noted that the endrin-coating treatment studied involved use of latex adhesive and aluminum coloring. Also, treated seed did not contain Arasan, which was eliminated from coating treatments in the Pacific Northwest in the late fifties because it inhibited germination slightly and did not seem to increase the effectiveness of endrin (Dick et al. 1958). It is not known whether results similar to those obtained in this study are possible when other coating treatments in which Arasan or different adhesives and coloring materials are used.

A recent investigation (Radwan et al. 1970) outlined methods for impregnating Douglas-fir seed with endrin and discussed germination, biological activity, and endrin content of impregnated seed. Results of the present study confirm previous observations that performances of unstored impregnated seed from the EDI and ETI treatments were, respectively, similar to and somewhat less than that of coated seed. The data also indicate that, as with coating, germination of impregnated seed remained essentially unchanged during storage for up to 4 months. This performance suggests that endrin solvents, especially 1, 2-dichloroethane used for the EDI impregnation treatment, did not have serious adverse aftereffects on the seed and that endrin remaining on and inside the seed was not detrimental during storage.

LITERATURE CITED

Anonymous.
1956. 1956 formulation for the treatment of coniferous tree seed. U.S. Fish and Wildl. Serv., Wildl. Res. Lab., Denver, 2 pp. (Spec. Release)

Association of Official Seed Analysts.
1965. Rules for testing seeds. Ass. Offic. Seed Anal. Proc. 54(2), 112 pp.

Barton, Lela V.
1954. Storage and packeting of seeds of Douglas fir and western hemlock. Contrib. Boyce Thompson Inst. 18: 25-37.

Dick, James, Finnis, J. M., Hunt, Lee O., and Kverno, Nelson B.
1958. Treatment of Douglas-fir seed to reduce loss to rodents. J. Forest. 56: 660-661.

Jones, LeRoy.
1963. Germination of repellent treated southern pine seed before and after storage. Southeastern Forest & Range Exp. Sta. USDA Forest Serv. Res. Note SE-15, 4 pp.

McLemore, B. F., and Barnett, J. P.
1966. Storing repellent-coated southern pine seed. J. Forest. 64: 619-621.

Radwan, M. A., Crouch, G. L., and Ellis, W. D.
1970. Impregnating and coating with endrin to protect Douglas-fir seed from rodents. Pacific Northwest Forest & Range Exp. Sta. USDA Forest Serv. Res. Pap. PNW-94, 17 pp., illus.

Snedecor, George W.
1961. Statistical methods applied to experiments in agriculture and biology. 534 pp. Ames: Iowa State Univ. Press.

GPO 996-778

Radwan, M. A., and Anderson, H. W.
1970. Storing endrin-coated and endrin-impregnated Douglas-fir seed. USDA Forest Serv. Res. Pap. PNW-95, 6 pp. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Application of endrin to Douglas-fir seed by coating at 0.5 percent or by soaking in endrin-dichloroethane solutions did not inhibit germination or seedling growth. Impregnation with endrin dissolved in trichloroethylene, however, reduced germination on perlite but not in soil. Regardless of storage temperature, germination and seedling growth of endrin-coated and endrin-impregnated seed after storage for up to 4 months was nearly the same as those of unstored seed.

Radwan, M. A., and Anderson, H. W.
1970. Storing endrin-coated and endrin-impregnated Douglas-fir seed. USDA Forest Serv. Res. Pap. PNW-95, 6 pp. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Application of endrin to Douglas-fir seed by coating at 0.5 percent or by soaking in endrin-dichloroethane solutions did not inhibit germination or seedling growth. Impregnation with endrin dissolved in trichloroethylene, however, reduced germination on perlite but not in soil. Regardless of storage temperature, germination and seedling growth of endrin-coated and endrin-impregnated seed after storage for up to 4 months was nearly the same as those of unstored seed.

Radwan, M. A., and Anderson, H. W.
1970. Storing endrin-coated and endrin-impregnated Douglas-fir seed. USDA Forest Serv. Res. Pap. PNW-95, 6 pp. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Application of endrin to Douglas-fir seed by coating at 0.5 percent or by soaking in endrin-dichloroethane solutions did not inhibit germination or seedling growth. Impregnation with endrin dissolved in trichloroethylene, however, reduced germination on perlite but not in soil. Regardless of storage temperature, germination and seedling growth of endrin-coated and endrin-impregnated seed after storage for up to 4 months was nearly the same as those of unstored seed.

Radwan, M. A., and Anderson, H. W.
1970. Storing endrin-coated and endrin-impregnated Douglas-fir seed. USDA Forest Serv. Res. Pap. PNW-95, 6 pp. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Application of endrin to Douglas-fir seed by coating at 0.5 percent or by soaking in endrin-dichloroethane solutions did not inhibit germination or seedling growth. Impregnation with endrin dissolved in trichloroethylene, however, reduced germination on perlite but not in soil. Regardless of storage temperature, germination and seedling growth of endrin-coated and endrin-impregnated seed after storage for up to 4 months was nearly the same as those of unstored seed.

Headquarters for the PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION is in Portland, Oregon. The Station's mission is to provide the scientific knowledge, technology, and alternatives for management, use, and protection of forest, range, and related environments for present and future generations. The area of research encompasses Alaska, Washington, and Oregon, with some projects including California, Hawaii, the Western States, or the Nation. Project headquarters are at:

College, Alaska
Juneau, Alaska
Bend, Oregon
Corvallis, Oregon
La Grande, Oregon
Portland, Oregon
Roseburg, Oregon
Olympia, Washington
Seattle, Washington
Wenatchee, Washington

The FOREST SERVICE of the U.S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation.